

Staying vigorous until work is over: The role of trait vigour, day-specific work experiences and recovery

Sabine Sonnentag* and Cornelia Niessen

Department of Psychology, University of Konstanz, Konstanz, Germany

Staying vigorous throughout the day is important for work related behaviour, subjective well being, and for effective functioning in the family domain. This study examined trait vigour (i.e. a person's general level of vigour), day specific workload (time pressure, work hours), and recovery resulting from unwinding during leisure time as predictors of day specific vigour as experienced at the end of the working day. Seventy five individuals from service and public administration organizations completed one general survey and daily surveys two times per day for five working days. Trait vigour, demographic variables and control variables (e.g. job control, home workload) were assessed in the general survey. Day specific level of vigour, day specific workload, and day specific recovery were measured in the daily survey. Analyses following a hierarchical linear modelling approach showed that trait vigour, day specific workload and recovery accumulated during the preceding evenings predicted an individual's level of vigour at the end of the working day, after controlling for a range of other variables (gender, age, job control, and home workload). Trait vigour and accumulated recovery experiences interacted significantly to predict vigour at the end of the working day, indicating that individuals high on trait vigour benefit most from recovery experienced over the course of several days.

There are days when you leave your workplace in the evening full of energy and feeling alive. There are also other days when at the end of the working day, you have no energy left and do not know how to deal with the responsibilities associated with family life. Such everyday experiences draw our attention to questions such as: What are the events and experiences at work that drain people's energy and reduce day-level vigour? Which events and experiences outside one's job help to protect and preserve vigour throughout the working day? What role does a person's general level of vigour play in day-level vigour?

Vigour is an affective construct (Shirom, 2004) and refers to the subjective experience of energy and aliveness (Peterson & Seligman, 2004; Ryan & Frederick, 1997). Feeling vigorous is not only a positive experience *per se*, but is extremely helpful

* Correspondence should be addressed to Dr Sabine Sonnentag, Department of Psychology, University of Konstanz, Postbox 42, Konstanz, D-78457, Germany (e-mail: sabine.sonnentag@uni-konstanz.de).

in everyday life, in particular at work and in the family, as vigour enables an individual to approach his or her tasks with more energy. As vigour is one aspect of positive affect (Ryan & Frederick, 1997; Sheldon, Ryan, & Reis, 1996), it may also stimulate creative, proactive, and other forms of extra-role behaviour at work (Ashby, Isen, & Turken, 1999; Fisher, 2002; Ilies, Scott, & Judge, 2006). For example, employees may show more personal initiative (Frese & Fay, 2001) and other types of proactive behaviour (Grant & Ashford, *in press*) when they experience a high level of vigour. Thus, vigour is essential for engaging in behaviours relevant for the organization.

Vigour also plays an important role at the work-family interface. Research on work-family conflict has shown that strains from one role (e.g. work) impair a person's functioning in the other role (e.g. family; Greenhaus & Beutell, 1985). This perspective implies that experiences at work deplete vigour and consume energy that would be needed at home. As a consequence, less energy is available when facing responsibilities at home such as caring for children and ageing parents (Neal & Hammer, 2007; Repetti & Wood, 1997) or when accomplishing household duties. More recent research on work-family facilitation and work-family enrichment suggests that experiences in one role may also help to meet the demands in the other role (Greenhaus & Powell, 2006; Rothbard, 2001). This approach suggests that affect resulting from performance in one role facilitates performance in the other role. For example, energy resulting from a successful day at work can spill over into the family domain and the employee might inspire his or her partner and children with new ideas about how to spend time together or how to solve problems at home.

Moreover, processes at home will influence the amount of vigour available at work. If social conflicts in the family deplete one's energy level and if one's life at home does not provide opportunities to restore one's energy resources, behaviour at work will suffer. However, if life at home helps to relax and regain vigour, this energy can be invested at the workplace (Sonnentag, 2003). A recent study suggests that the degree to which engagement in one role provides energy for the other role is related to positive outcomes at work (e.g. job performance, work satisfaction) and at home (e.g. home satisfaction; van Steenbergen, Ellemers, & Mooijaart, 2007). Taken together, previous research showed that work and family life are closely connected; this research suggests that vigour is one of the core linking mechanisms between work and family life.

The purpose of the present study is to examine predictors of vigour from a day-level perspective. More specifically, we will address the question if day-specific workload (Butler, Grzywacz, Bass, & Linney, 2005; Zohar, Tzischinski, & Epstein, 2003) and the day-specific degree to which a person has recovered during off-job time (Sonnentag & Natter, 2004) are related to a person's level of vigour experienced during a specific day. In other words, we focus on the daily fluctuation of vigour within persons. In addition, we test whether a person's general (i.e. trait) level of vigour moderates the relationship between day-level recovery and day-level vigour. In other words, we examine if persons high on trait vigour benefit more or less from recovery (see Figure 1 for the conceptual model). We use the conservation of resources (COR) approach (Hobfoll, 1998) as a general framework for our study. According to the COR approach, people aim at obtaining, retaining, and fostering resources. Within this framework, 'resources' is a broad term that refers objects, conditions (e.g. being healthy), personal characteristics, and energies that are valued in itself or that help in achieving such objects, conditions, characteristics, or energies. Vigour is an important energetic resource (Shirom, 2004). A person's actual level of vigour might be influenced by resource-providing (e.g. recovery experiences) and resource-draining processes and events (e.g. a high workload).

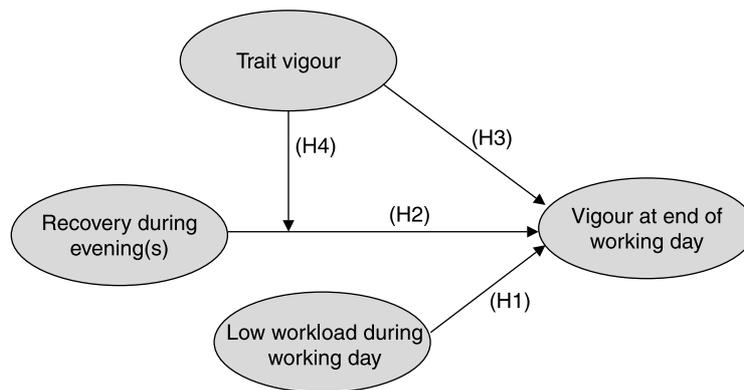


Figure 1. Conceptual model.

Gaining knowledge about how daily workload and daily recovery experiences are related to vigour is relevant for both the work and the home domain and will shed more light on the processes that link the two domains (Edwards & Rothbard, 2000; Greenhaus & Powell, 2006). A finding that day-specific workload is negatively related to vigour at the end of the working day may offer an explanation why a high workload adds to work-family conflict (Ilies *et al.*, 2007). Moreover, demonstrating relationships between workload and recovery on the one hand and vigour on the other hand will also have implications for practical interventions. If it turns out that daily workload is related to low vigour, job design efforts, or stress management programs can be initiated (Semmer, 2003). Similarly, if recovery demonstrates itself as a predictor of vigour, recommendations for recovery during off-job time can be derived.

Vigour concept

Vigour – or vitality – is a dynamic aspect of individual well-being characterized by the subjective feeling of energy and aliveness (Peterson & Seligman, 2004; Ryan & Frederick, 1997). Shirom (2004) defined vigour as feelings of physical strength, emotional energy, and cognitive liveliness. Thus, vigour relates both to somatic and psychological factors and is reflected in subjective experiences of being alive and vital or having energy and spirit. We view vigour as an activated positive affect that thereby can be differentiated from other energetic experiences (e.g. tension, anger) by its positive tone and from mere happiness by its high activation level (Nix, Ryan, Manly, & Deci, 1999).

Similar to other affective concepts (Eid & Diener, 1999; Watson & Clark, 1994), vigour can be seen as both a trait and a state concept. This view implies between-individual and within-individual variation of vigour levels: individuals differ in the general (or average) levels of vigour (Peterson & Seligman, 2004; Ryan & Frederick, 1997); moreover, within each individual there is variation in vigour across days (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000; Ryan & Frederick, 1997, Study 6). For example, in general a person might experience a high vigour level (as compared to other persons), but after a stressful day at work this person's momentary vigour level decreases substantially – until it raises again during an enjoyable evening spent with his or her spouse. In our study, we examine both trait and state aspects of vigour.

Past research has linked somatic processes (e.g. exercise, food intake; Thayer, 1987, 2001) and psychological processes related to self-determination (Nix *et al.*, 1999; Reis *et al.*, 2000) to individual levels of vigour. Research that has conceptualized vigour in a work context is still rare (for exceptions see, Quinn & Dutton, 2005; Schaufeli, Bakker, & Salanova, 2006; Spreitzer, Sutcliffe, Dutton, Sonenshein, & Grant, 2005). Particularly little is known whether stressors such as a high workload encountered on the job and processes related to recovery and unwinding from these stressors matter with respect to vigour.

Day-specific workload and vigour

Workload refers to the amount of work to be accomplished (Spector & Jex, 1998). In most cases, a high level of workload is experienced as high time pressure and is also reflected in the number of hours worked (Major, Klein, & Ehrhart, 2002). From a between-person perspective, there is broad empirical evidence that a high workload is associated with strain and poor psychological well-being (De Lange, Taris, Kompier, Houtman, & Bongers, 2003; Podsakoff, LePine, & LePine, 2007). In addition, research adopting a within-person perspective showed that periods of high workload are associated with impaired well-being such as negative mood, emotional exhaustion, and increased anxiety (Teuchmann, Totterdell, & Parker, 1999; Totterdell, Wood, & Wall, 2006).

According to COR theory, stress occurs when resources are threatened, when resources are lost, and when efforts to gain resources (e.g. by investment of other resources) are not successful (Hobfoll, 1998). A high workload and other stressors encountered at work typically threaten resources and tend to reduce a person's momentary level of vigour. When facing a high degree of workload, particularly when working under high time pressure, individuals have to work fast and have to invest a lot of effort in order to accomplish their tasks (Frese & Zapf, 1994; Hockey & Earle, 2006). Effort investment requires energy resources. Although effort investment itself is often associated with concurrent positive affect (Fisher & Noble, 2004) it can have negative consequences in the longer run. When a high workload continues over long hours, energy resources tend to become depleted (Zohar *et al.*, 2003) and less energy will be available for subsequent activities. This decline in energy resources will be experienced as a decrease in vigour. Similarly, working for longer hours depletes energy resources more than working for shorter periods of time (cf. Geurts & Sonnentag, 2006). As a consequence, vigour should decrease after having worked long hours.

Hypothesis 1: High day specific workload (time pressure, long work hours) is negatively related to vigour at the end of the working day.

Recovery

We propose that recovery experiences attained during leisure time are related to vigour at the end of the working day. Generally, recovery can be described as a process opposite to the strain process. The effort-recovery model (Geurts & Sonnentag, 2006; Meijman & Mulder, 1998) and the COR theory (Hobfoll, 1998) are the two most influential theoretical frameworks that describe recovery from job-related stress. The effort-recovery model states that spending effort in order to fulfil task requirements at work causes strain reactions in the person. Such strain reactions might manifest themselves in sympathetic activation (e.g. increased blood pressure) or also in more

subjective indicators (e.g. increase in fatigue). To restore his or her performance capability, the person needs to recover from the effortful experiences at work, preferably by not calling upon the functional systems that have been challenged when the person was at work (e.g. by not continuing to work, but rather engaging in different types of activities or refraining from any effortful activity). If this recovery process is successful, the person will be able to start the new working period refreshed and with new energy. However, if recovery remains incomplete and the person returns to work, he or she must invest additional effort in order to overcome the performance impairments caused by lack of recovery. This additional compensatory effort will result in larger strain reactions that will increase the person's need for recovery even further.

Although using a different terminology, COR theory agrees with the effort-recovery model in assuming that refraining from activities that are similar to the activities that caused the strain reactions will help to achieve recovery (i.e. restoration of resources). Moreover, the COR theory assumes that investment of additional resources can rebuild threatened and lost resources. Thus, investment of free time, positive experiences, and other resources can increase recovery.

Typically, recovery takes place during work breaks (Trogakos, Beal, Green, & Weiss, 2008), in the evenings after work (Rook & Zijlstra, 2006), and during weekends or vacations (Fritz & Sonnentag, 2005; Westman & Eden, 1997). Recovery results in an improved affective state and in a reduction of physiological strain indicators (Linden, Earle, Gerin, & Christenfeld, 1997; Totterdell, Spelten, Smith, Barton, & Folkard, 1995). When an individual lacks recovery over longer periods of time, longer-term impairments of psychological and physical health may result (deCraon, Sluiter, & Blonk, 2004; Kivimäki *et al.*, 2006).

Recovery experiences during off-job time should help reduce symptoms of previous strain processes. A full degree of recovery is attained when the person feels that his or her physical, cognitive, and emotional systems called upon during work have returned to a baseline level (Craig & Cooper, 1992). Previous research on recovery during evenings has demonstrated that specific recovery activities (e.g. sport and exercise), as well as the subjective experience of being recovered, predict vigour and other well-being indicators at bedtime (Sonnentag, 2001; Sonnentag & Natter, 2004).

When having experienced recovery during the preceding evenings and returning in a well-recovered state back to work in the mornings, energy resources become available and can be invested into the task accomplishment process. Being in a recovered state helps individuals to actively approach work tasks without having to mobilize extra effort that may deplete energy resources (Binnewies, Sonnentag, & Mojza, *in press*; Sonnentag, 2003). As a consequence, vigour is more likely to remain high during the course of the working day. Conversely, without recovery, the same work requires extra effort; this compensatory effort will further deplete energy resources (Binnewies *et al.*, *in press*). On the subjective level, this depletion of energy will be experienced as a decrease in vigour. Moreover, when working while not being fully recovered, negative affect at work will increase (Trogakos *et al.*, 2008). Attempts to regulate such negative affective states will deplete energy resources (Muraven & Baumeister, 2000) and as a consequence, vigour will be further reduced.

With respect to the timing of the recovery experiences, one can think of two processes: First one might argue, that in terms of subsequent vigour, recovery attained during the immediately preceding evening matters most. Second, it might be that

accumulating recovery over several evenings is important as one evening alone may not have the power to overcome strain levels that built up over several days. In our study, we will examine both recovery on the preceding evening and accumulated recovering over preceding evenings.

Hypothesis 2: Having experienced recovery during the preceding evening(s) will be positively related to vigour experienced at the end of the working day.

Trait vigour

Individuals differ in their general (i.e. trait) level of vigour. For example, individuals who show high levels of extraversion, life satisfaction, self-esteem and who follow a healthy life-style tend to experience higher levels of trait vigour than individuals scoring low on these attributes (Peterson & Seligman, 2004; Ryan & Frederick, 1997).

We propose that an individual's trait level of vigour will be positively related to the individual's level of vigour at the end of the working day. One explanatory mechanism for such a link between trait and state vigour refers the assumption that individuals choose situations that correspond to their dispositions and avoid those that do not match their dispositions (Emmons, Diener, & Larsen, 1986). Research has shown that an individual's general affective disposition is related to the experience of specific affective states corresponding to this disposition (Bolger & Schilling, 1991; Marco & Suls, 1993). For example, with respect the positive affective traits and states it has been demonstrated that individuals scoring high on 'positive' features of personality (i.e. extraversion) experience higher levels of positive affective states in everyday situations (Davis, Green, Martin, & Suls, 1997; Zautra, Affleck, Tennen, Reich, & Davis, 2005).

Hypothesis 3: Trait vigour is positively related to day specific vigour at the end of the working day.

Trait level of vigour may not only be directly related to a person's day-level of vigour, but may also impact an individual's response to other events and experiences. Specifically, we propose that trait vigour interacts with recovery experiences when predicting day-level vigour. Individuals high on trait vigour will be more responsive to recovery after work than individuals low on trait vigour. We view trait vigour as a resource that helps individuals to gain the most from their recovery experiences.

Researchers largely agree that the positive affective system and the negative affective system are two distinct systems corresponding to distinct neuropsychological processes (Cacioppo & Gardner, 1999; Watson, Wiese, Vaidya, & Tellegen, 1999). Trait affect influences individuals' responses to positive and negative stimuli (Watson *et al.*, 1999). The positive affective system of positively disposed individuals (i.e. individuals high on trait positive affect, but also individuals high on extraversion) reacts more strongly to positive stimuli and reward cues than of less positively disposed individuals, whereas the negative affective system of negatively disposed individuals reacts more strongly to negative stimuli and punishment cues (Larsen & Ketelaar, 1989, 1991). As vigour is an affect characterized by high positive activation (Peterson & Seligman, 2004) and is positively related to trait positive affect and extraversion (Ryan & Frederick, 1997), it can be subsumed under the positive affective system. Therefore, one can expect that persons scoring high on trait vigour should be more responsive to positive stimuli than are persons scoring low on trait vigour.

The stimuli to which an individual responds more easily need not to be necessarily external ones, but can also be self-generated experiences and behaviours that fit the individual's affective disposition. For example, Judge and Ilies (2004) demonstrated that in individuals high on trait positive affect, day-specific job satisfaction (as reported during the working day) was more strongly related to positive mood at home than in individuals low in trait positive affect. In other words, a positive day-specific experience (i.e. job satisfaction) was more strongly related to a specific affective state (i.e. positive mood at home) when the day-specific experience corresponded to the trait (trait positive affect).

Similarly, one can assume that individuals high on trait vigour respond more positively to recovery experiences, that is to experiences that correspond to their general tendency to feel energetic and to their ability to regain energy quickly. As a consequence recovery experiences will be more strongly related to day-level vigour in individuals high on trait vigour. Individuals low on trait vigour, however, will react less positively to recovery experiences because these experiences do not match with their disposition. As a consequence they will benefit less from these recovery experiences in terms of day-level vigour.

Hypothesis 4: Trait vigour moderates the relationship between recovery experienced during the preceding evening(s) and day specific vigour at the end of the working day: individuals high on trait vigour will benefit more from recovery experiences than individuals low on trait vigour.

Method

Sample and procedure

To recruit study participants, we contacted small companies in various service industries and departments of public administration organizations in Germany, presented the study as research on 'stress and recovery' and asked for participation. We chose these service and public administration organization to cover a broader range of different jobs. However, we explicitly excluded industries where heavy physical work demands are imposed on the employees as these might have an additional effect on the experience of vigour. After managers agreed that the companies or departments would participate, we sent out a total of 149 survey packages, including a general survey, a daily survey booklet covering five working days, a letter explaining the study and a return envelope to prospective study participants. Participants were instructed to return the completed surveys directly to the researchers.

In total, 77 persons responded to the general and daily surveys (response rate = 51.7%). The daily surveys returned by two of the participants did not include any usable data, resulting in a total of 75 participants (57.3% male). Of these 75 participants, 33.3% worked in public administration organizations dealing with local and regional affairs, 32.0% worked in insurance companies, 22.7% worked in small engineering firms, and 12.0% worked in other organizations such as public relation agencies. In terms of education, the sample was rather highly skilled, with 40.5% of the participants having obtained a university degree, 44.6% having completed a professional 2- to 3-year education, and 9.5% having completed advanced training in addition to the professional 2- to 3-year education. Only 5.4% reported to have no professional degree. Mean job experience was 13.9 years ($SD = 10.7$). Mean contract working time was 35.8 hours per week ($SD = 8.1$). In terms of life-situation, 13.3% lived alone, 77.4% lived with a partner, 1.3% were single parents, and 8.0% lived with people other than partners, parents, or children. Overall, 48.0% of the participants had at least one child.

Measures

We gathered our data with a general survey to be filled in once and daily surveys to be completed on five working days immediately after returning home from work and in the evenings at bedtime. We chose to collect data over 5 days in order to keep the burden on study participants at a bearable level. Respondents were instructed to complete the workload and day-specific vigour measures at the end of the working day (i.e. immediately after they returned home from work), and the recovery measures at bedtime (i.e. immediately before going to sleep). In the analysis we linked daily survey data on recovery gathered in the evenings of the preceding days with vigour data assessed after work on the days to come. Therefore, for every study participant we had a maximum of four bedtime-to-after-work sequences. This study design allowed us to examine within-person processes and to move beyond the limitations of more traditional cross-sectional designs. Means, standard deviations, and zero-order correlations for all variables are shown in Table 1. All items were in German.

Workload

In the daily survey administered at the end of the working day, we assessed day-specific time pressure and day-specific working hours as indicators of workload. For measuring day-specific time pressure we used three items from a scale developed by Semmer (Semmer, 1984; Zapf, 1993) and adapted it to the day-level. A sample item was 'Today I worked under time pressure'. Responses were given on five-point scales (1 = *I do not agree at all*; 5 = *I do fully agree*). Cronbach's α for the four working days included in the analyses ranged between .87 and .89 (mean = 0.88). We assessed day-specific working hours with a single item ('How many hours did you work today?').

Recovery

Recovery is a process opposed to the strain process and manifests itself in an improvement of affect and a reduction of strain symptoms. In this study, we used two different recovery variables: The first measure captured recovery attained during the preceding evening. We developed a second recovery measure that reflected recovery accumulated over several preceding evenings (i.e. all preceding evenings included in data collection) because lack of recovery may accumulate over time (Meijman & Mulder, 1998). We arrived at these measures by using the following procedure: in the bedtime surveys we provided short descriptions of three types of leisure time activities developed in an earlier study (Sonnentag, 2001): (a) low effort activities (e.g. watching TV, taking a bath); (b) social activities (e.g. meeting with friend); and (c) physical activities (e.g. sport, exercise) and asked participants if they had spent time on each type of these activities. If the participants responded 'no', they were asked to proceed to the next question. If they responded 'yes', they were instructed to report the amount of time devoted to each type of activity and to respond to three recovery items referring to the specific type of activity ('I felt more recovered after having performed this activity', 'I felt more relaxed after having performed this activity', and 'I was in a good mood after having performed this activity') on a five-point scale (1 = *I do not agree at all*; 5 = *I do fully agree*). Cronbach's α for recovery attained through low-effort activities ranged between .87 and .90 (mean = 0.89), for recovery attained through physical activities ranged between .82 and .91 (mean = 0.88) and for recovery attained through social activities ranged between .71 and .90 (mean = 0.84). Mean recovery

Table 1. Mean, standard deviation, and intercorrelations of study variables

	M	SD	1	2	3	4	5	6	7	8	9	10
1. Gender	1.57	0.50										
2. Age	37.87	9.84	.16									
3. Home workload	2.39	0.71	-.17	-.13								
4. Job control	3.74	0.71	.14	.37	-.08							
5. Trait vigor	4.29	0.99	-.05	-.08	-.27	.30						
6. Recovery preceding evening	3.22	0.51	.07	-.12	-.20	.05	.26		.27	-.01	.01	.08
7. Accumulated recovery	3.20	0.57	.03	-.13	-.24	.08	.33	.91	-.14	-.07	.20	.35
8. Work hours	8.12	1.22	.37	.15	-.24	.03	.04	-.23	-.22	.32	.20	-.20
9. Time pressure	2.72	0.77	.15	.02	-.02	.05	-.01	.00	-.02	.32	.20	-.20
10. Day-evening vigor	3.50	0.90	-.01	-.21	-.08	.18	.53	.51	.49	-.09	-.15	-.20

Note. Correlations below the diagonal are correlations at the person level ($N = 75$; correlations $\geq .22$ are significant at $p < .05$ level, correlations $\geq .30$ are significant at $p < .01$ level). Correlations above the diagonal are correlations at the day level ($N = 298$; correlations $\geq .15$ are significant at $p < .01$ level).

ratings were 3.63 for low-effort activities ($SD = 0.77$), 4.02 for physical activities ($SD = 0.68$), and 3.67 for social activities ($SD = 0.76$). For each evening, we averaged the recovery ratings provided for the three types of activities and thereby attained evening-specific recovery ratings.

One might argue that these average recovery scores overrepresented recovery experiences from activities that were performed only for a short period of time and underrepresented recovery experiences from activities that were performed for longer periods of time. To examine if simply averaging recovery experiences across activities threatens the quality of our data, we additionally computed weighted recovery scores by weighting the recovery experience of each activity category by the time spent on this activity on the specific day. Correlations between unweighted and weighted recovery experience scores ranged between $r = .97$ and $r = .99$ for the four evenings. Because of these high correlations we are confident that our findings are not biased by the specific calculation procedure of the recovery experience scores. For further analyses, we used the unweighted scores.

To arrive at a score of accumulated recovery (i.e. our second recovery measure), we summed up the recovery ratings of the preceding evenings. Specifically, recovery on Evening 1 was the average recovery rating from Evening 1. Recovery on Evening 2 was computed by averaging the recovery ratings from Evening 1 and Evening 2. Recovery on Evening 3 was computed by averaging the recovery ratings from Evening 1, Evening 2, and Evening 3, etc. Within-day correlations between recovery on the preceding evening and accumulated recovery were $r = 1.00$ (Day 2), $r = .87$ (Day 3), $r = .66$ (Day 4), and $r = .76$ (Day 5).

Day-specific vigour

We measured day-specific vigour in the daily survey at the end of the working day. Specifically, study participants were asked to respond to four items (e.g. 'vigorous', 'lively', 'active', and 'full of pep') from the German version (Bullinger, Heinisch, Ludwig, & Geier, 1990) of the profile of mood scales (POMS; McNair, Lorr, & Droppelman, 1971) and to indicate on a seven-point scale (1 *not at all*; 7 *very much*) how the specific items described their state 'at the moment'. This vigour scale belongs to the most widely used vigour measures (Gump, 1997; Puetz, O'Connor, & Dishman, 2006) and shows satisfactory construct validity (Peterson & Seligman, 2004). Cronbach's α computed separately for each day ranged from .91 to .94 (mean = 0.92).

Trait vigour

We assessed trait vigour with the same four items from the POMS (Bullinger *et al.*, 1990; McNair *et al.*, 1971) as used for measuring day-specific vigour. We asked study participants to respond to the vigour items with respect to their experience 'in general' on a seven-point scale (1 *not at all*; 7 *very much*). Cronbach's α was .87. We used the same items for assessing state and trait vigour to ensure that both measures capture the same construct.

Control variables

We included gender, age, job control, and home workload as control variables. Gender might be related to vigour at the end of the working day because women might anticipate more household-related tasks when coming home from their jobs

(cf. Lundberg, Mardberg, & Frankenhaeuser, 1994) what might reduce vigour. Work might be more fatiguing for older individuals (cf. Jennings *et al.*, 1997; Uchino, Berg, Smith, Pearce, & Skinner, 2006), leading to reduced vigour in older employees. Job control has been shown to be related to vigour and vitality at work (Demerouti, Bakker, de Jonge, Janssen, & Schaufeli, 2001; Lerner, Malspeis, & D'Agostino, 1994). Moreover, individuals facing a high workload in their non-work domain (household chores, child care, caring for own parents) might experience lower levels of vigour because they anticipate demands from these other task domains.

We assessed gender and age with single items. We measured job control with five items from Semmer (1984) and Zapf (1993) on a five-point scale (1 *very little*; 5 *very much*). A sample item was 'Can you yourself decide on which way to carry out your work?' Cronbach's α was .78. For assessing home workload we used eight items from the total workload questionnaire measures (cf. Lundberg *et al.*, 1994; Mardberg, Lundberg, & Frankenhaeuser, 1991). A sample item was 'My household and/or child care duties require much effort'. Five-point response scales were used (1 *I do not agree at all*; 5 *I do fully agree*). Cronbach's α was .85.

Data analysis

Our data had a hierarchical structure with days nested within persons. Therefore, we analysed our data with a hierarchical linear modelling approach (Bryk & Raudenbush, 1992; Snijders & Bosker, 1999) using the MLwiN software (Rasbash *et al.*, 2000). We centred work hours, time pressure, and recovery during the preceding evening(s) at the respective person mean and all other variables at the grand mean. By centring some of the variables at the person mean, we removed all between-person variance in these variables, which allows us to rule out that the study findings are accounted for by more stable differences in participants' levels of time pressure, work hours, or recovery.

Results

Preliminary analyses

Before testing our hypotheses, we examined the within-person and the between-person variance of day-specific after-work vigour with a Null Model. Within-person variance was 0.710, and between-person variance was 0.659. Thus, 51.9% of the total variance of day-specific after-work vigour was within-persons, indicating that individuals differ largely from day-to-day in their level of vigour experienced at the end of the working day.

Test of hypotheses

To test our hypotheses we compared several nested hierarchical linear models. First, we built a Null Model with the intercept as the only predictor. In Model 1, we entered person-level control variables (gender, age, job control, home workload). In Model 2, we added trait vigour as a predictor variable. In Model 3, we entered recovery and workload variables (work hours, time pressure) as our predictor variables. Finally, in Model 4 we included the interaction term between trait vigour and recovery. To examine the improvement of each model above the previous one, we used the likelihood statistics of the respective models and compared them by using a χ^2 -test. We ran separate sets of analyses for the two recovery measures.

Table 2 shows the findings from hierarchical linear modelling for recovery on the preceding evening as one of the predictor variables. Model 1 that included the control variables did not reveal a better fit than the Null Model ($\Delta 2 \times \log = 8.348$; $df = 4$; *ns*). Model 2 with trait vigour as additional predictor variable showed an improved fit ($\Delta 2 \times \log = 17.634$; $df = 1$; $p < .001$). Model 3 fitted the data better than Model 2 ($\Delta 2 \times \log = 31.521$; $df = 3$; $p < .001$) with work hours and time pressure being negatively related to vigour at the end of the working day. Recovery from the preceding evening was not related to vigour at the end of the working day. The interaction term between trait vigour and this recovery measure entered in Model 4 did not result in a significant improvement of the model ($\Delta 2 \times \log = 0.198$; $df = 1$; *ns*). In addition to the analysis reported here that basically reflect within-person associations, we ran a second set of analyses in which we used grand-mean centred (instead of person-mean centred) recovery measures. Thus, this analysis addressed between-person associations. Also in this analysis, neither the relationship between recovery and vigour nor the interaction term were significant.

To examine if recovery accumulated over the preceding evenings is associated with vigour at the end of the working day we ran an additional set of analyses (see Table 3). The Null Model, Model 1, and Model 2 were identical to the respective models tested in the previous sets of analyses. Model 3a that included work hours, time pressure, and recovery accumulated over the preceding evenings resulted in an improvement of model fit ($\Delta 2 \times \log = 34.514$; $df = 3$; $p < .001$) with both work hours and time pressure being negatively related and accumulated recovery being positively related to vigour at the end of the working day. The interaction term between trait vigour and recovery entered in Model 4 further contributed to an improved model fit ($\Delta 2 \times \log = 4.302$; $df = 1$; $p < .05$). To explore the pattern of the interaction effect, we computed simple slope tests following the procedure suggested by Aiken and West (1991). For participants with a low level of trait vigour (1 *SD* below the mean), recovery experience was not related to day-specific vigour ($\gamma = 0.070$, $SE = 0.177$; *ns*) whereas for participants with high levels of trait vigour (1 *SD* above the mean), recovery was significantly related to day-specific vigour ($\gamma = 0.532$, $SE = 0.167$; $t = 3.186$; $p < .01$). This pattern of interaction is displayed in Figure 2. Thus, this finding that individuals high on trait vigour benefited most from recovery supported Hypothesis 4.

Test for reversed causation

One might argue that not only recovery impacts on vigour, but that also a reversed causal process might occur. For example, when a person experiences vigour at a given moment, he or she might search for or create more effective recovery opportunities. To rule out this interpretation, we performed an additional set of analyses in which we tested if day-specific vigour experienced after work predicts recovery later at the evening. Hierarchical linear modelling showed that day-specific vigour did not add significantly to the prediction of recovery after controlling for gender, age, job control, home workload as control, day-specific time pressure, and day-specific work hours ($\Delta 2 \times \log = 2.169$; $df = 1$; *ns*; $\gamma = 0.059$; $SE = 0.040$; $t = 1.475$; *ns*). Also when excluding all control variables, the estimate of vigour did not reach significance. Findings from this additional analysis rule out that day-specific vigour predicts recovery.

Table 2. Results from hierarchical regression analysis for recovery on the preceding evening

	Null Model		Model 1		Model 2		Model 3		Model 4	
	Estimate	SE								
Intercept	3.463	0.107	3.472	0.102	3.478	0.090	3.457	0.089	3.457	0.090
Gender			-0.017	0.211	0.091	0.189	0.070	0.187	0.070	0.187
Age			-0.029	0.012	-0.019	0.010	-0.019	0.010	-0.019	0.010
Job control			0.358	0.157	0.115	0.149	0.141	0.148	0.140	0.148
Home workload			-0.086	0.147	0.099	0.137	0.086	0.135	0.087	0.135
Trait vigour					0.467	0.104	0.454	0.103	0.454	0.103
Recovery preceding evening							-0.110	0.101	-0.109	0.101
Work hours										
Time pressure										
Trait vigour X recovery preceding evening										
-2 × log (ll)	799.127		790.779		773.136		741.615		741.417	
Diff -2 × log			8.348		17.634***		31.521***		0.198	
df			4		1		3		1	
Level 1: intercept variance (SE)	0.710 (0.071)		0.708 (0.071)		0.709 (0.070)		0.611 (0.061)		0.610 (0.061)	
Level 2: intercept variance (SE)			0.575 (0.127)		0.410 (0.101)		0.425 (0.099)		0.426 (0.099)	

Note. *p < .05; **p < .01; ***p < .001.

Table 3. Results from hierarchical regression predicting vigour at the end of the working day (analysis for accumulated recovery)

	Null Model			Model 1			Model 2			Model 3			Model 4		
	Estimate	SE	t	Estimate	SE	t	Estimate	SE	t	Estimate	SE	t	Estimate	SE	t
Intercept	3.463	0.107	32.364	3.472	0.102	34.039	3.478	0.090	38.644	3.456	0.084	41.143	3.412	0.084	40.619
Gender				-0.017	0.211	-0.081	0.091	0.189	0.481	0.059	0.175	0.337	0.057	0.170	0.335
Age				-0.029	0.012	-2.417*	-0.019	0.010	-1.900	-0.016	0.010	-1.600	-0.014	0.010	-1.400
Job control				0.358	0.157	2.280	0.115	0.149	0.772	0.125	0.138	0.906	0.080	0.136	0.588
Home workload				-0.086	0.147	-0.585	0.099	0.137	0.723	0.133	0.128	1.039	0.139	0.124	1.121
Trait vigour							0.467	0.104	4.490***	0.412	0.099	4.162***	0.427	0.096	4.448***
Accumulated Recovery										0.302	0.136	2.250*	0.299	0.133	2.248*
Work hours										-0.179	0.040	-4.475***	-0.182	0.040	-4.550***
Time pressure										-0.220	0.075	-2.933**	-0.222	0.075	-2.960***
Trait vigour × accumulated recovery													0.248	0.118	2.102*
-2 × log (lh)	799.127			790.779			773.136			738.622			734.318		
Diff -2 × log				8.348			17.634***			34.514***			4.302*		
df				4			1			3			1		
Level 1: intercept variance (SE)	0.710 (0.071)			0.708 (0.071)			0.709 (0.070)			0.632 (0.063)			0.633 (0.063)		
Level 2: intercept variance (SE)	0.659 (0.141)			0.575 (0.127)			0.410 (0.101)			0.346 (0.087)			0.315 (0.082)		

Note. *p < .05; **p < .01; ***p < .001.

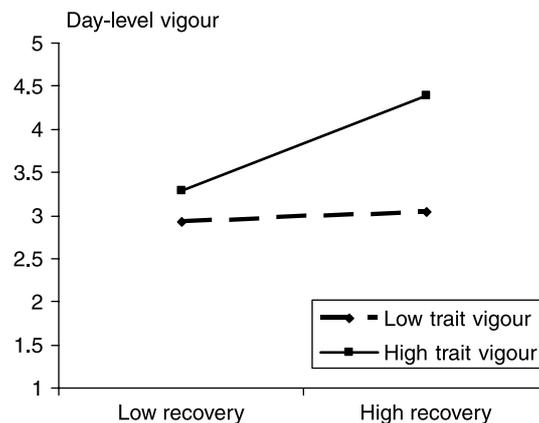


Figure 2. Interaction of accumulated recovery and trait vigour predicting day level vigour.

Discussion

Our day-level study showed that vigour at the end of the working day is predicted by both on-the-job and off-the-job experiences. Specifically, a low level of day-specific workload and favourable recovery experiences accumulated over the preceding days are related to high levels vigour at the end of a working day. Trait vigour was also found to be positively related to day-specific vigour and to moderate the relationship between recovery experiences and day-specific vigour with persons high on trait vigour experiencing a higher level of day-specific vigour after having recovered well.

Previous research on job stress in general and on workload in particular has focused on negative aspects of impaired well-being as outcomes of stressful work situations. Our study supported Hypothesis 1 demonstrating that comparatively low levels of day-specific time pressure and working hours are related to increased vigour – as a *positive* indicator of well-being. Low workload seems not only to prevent disturbances of well-being, but may also increase vigour. Since we used person-centred workload variables in our analyses, our findings do not imply that absolutely low levels of workload are related to high levels of vigour, but low workload as compared to a person's mean level of workload. It might be that this relative aspect of day-specific workload is crucial for experiencing vigour at the end of the working day. It might be that based on their person-specific average experiences, individuals have internal 'set points' or comparison values about typical and acceptable levels of workload. When workload (i.e. time pressure, work hours) exceeds this internal comparison value on a specific day, more effort investment is needed resulting in a drain of energy and in a decrease in vigour. When workload does not reach this internal comparison value, time and energy is left and may be experienced as an increased level of vigour.

With respect to the mediating mechanism underlying the negative relationship between time pressure and vigour, we proposed that high effort expenditure needed to cope with high time pressure accounts for a low level of vigour at work. In addition, one might argue that processes related to self-determination (Reis *et al.*, 2000; Ryan & Deci, 2000) also play an important role. When day-specific time pressure is relatively low, individuals have more time available to engage in behaviours that correspond to their

needs to for autonomy, competence, and relatedness. As a consequence, vigour will increase. In addition, it might be that on days when time pressure is relatively low, individuals take more short breaks in between when they start feeling fatigued. However, when time pressure is high, they may skip the breaks what reduces vigour until the end of the working day. Future studies might include measures of both effort expenditure and need satisfaction in order to test for mediators in the relationship between workload and low vigour.

Between-person and within-person studies revealed that workload on the job is related to work-family conflict (Butler *et al.*, 2005; Geurts, Kompier, & Roxburgh, 2003; Ilies *et al.*, 2007). Our study suggests that decrease in vigour due to a high workload might be one of the mediators in this relationship. A high workload reduces vigour, and this low level of vigour may in-turn increase work-family conflict - the feeling that work interferes with life at home - because work drains energy needed to cope with demands at home.

With respect to recovery experiences, our study extends previous research by demonstrating that recovery is not only reflected in an immediate improvement of well-being and an increase in work engagement and proactive behaviour *during* the subsequent work day (Rook & Zijlstra, 2006; Sonnentag, 2001, 2003). In partial support for Hypothesis 2, we found that the benefits of recovery experiences can persist until the work day is over. Thus, recovery accumulated during the preceding evenings might help to approach one's non-work life in a more vigorous way and to face challenges off the job with more energy and vitality. This interpretation fits nicely into the effort-recovery model (Meijman & Mulder, 1998) that proposes that recovery is needed so that persons are able to spend effort at work. In addition, the finding on the positive association between recovery and subsequent vigour can also be interpreted in the context of family-to-work enrichment processes (Greenhaus & Powell, 2006; Rothbard, 2001). Accumulated recovery at home can be seen as an experience that enriches and facilitates functioning at work, for example by increasing vigour at work or by reducing strain during work what in-turn keeps vigour experienced after work at a relatively high level. In terms of the COR framework (Hobfoll, 1998), recovery processes and subsequent increase in vigour may constitute gain spirals with recovery increasing vigour than in-turn helps to engage in effective recovery activities.

The finding that recovery experiences accumulated over the previous evenings - and not the recovery experience attained during the immediately preceding evening - predict vigour is noteworthy as it points to the cumulative process associated with recovery. It seems that recovery experiences of one evening may not be sufficiently powerful to be reflected in increased vigour states after a day of work. Similarly, poor recovery experiences on one evening seem to be not strong enough for affecting vigour and might, for example, be compensated by a good night's sleep (Scott & Judge, 2006). The effect of poor recovery on several days seems to build-up over time and relates to subsequent low vigour levels. We recommend that future research examine in more detail the exact qualities and processes that accumulate over time. One may speculate that by experiencing recovery, individuals gain self-regulatory resources (Muravan & Baumeister, 2000) that build-up over time.

Our study provided support for Hypotheses 3 and 4. The interaction between trait vigour and accumulated recovery experiences implies that in practical terms, persons high on trait vigour are able to use moderate to high recovery experiences in order to maintain vigour after a day at work. Persons with low scores on trait vigour do not benefit as much from recovery experiences, even not from extensive accumulated

recovery experiences occurring during evenings after work. It is possible that these persons need to engage more deliberately in activities that are particularly powerful in providing vigour and energy. Sports and exercise likely qualify as highly effective recovery activities (Thayer, 2001) that might be particularly important for individuals low on trait vigour. In addition, the interaction effect suggests that not all individuals benefit in a similar way from recovery experiences occurring within rather short time frames (i.e. evenings after work). It might be that for individuals low on trait vigour, free evenings after work are not sufficient for recovery. These individuals may need longer time periods (e.g. weekends or vacations; cf. Fritz & Sonnentag, 2006) in order to recover from job stress.

Moreover, an additional interpretation of the interaction between trait vigour and accumulated recovery should be noted: trait vigour is positively related to vigour at the end of the working day when accumulated recovery is high. However, lack of accumulated recovery attenuates this relationship. After a few days of low recovery also individuals high on trait vigour do not uphold their high vigour level at the end of the working day.

Limitations

As in most other research, our study is not without limitations. One of the most obvious limitations is that we assessed all of our variables with self-report measures. When studies exclusively rely on self-report measures, common method bias may limit the validity of the study findings (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Although we cannot completely rule out common method bias, our approach of centring most day-level predictor variables around the respective person mean, should reduce concerns that inter-individual traits (e.g. trait negative affectivity, social desirability) account for our study findings because this centring approach removed all person-level variance from the day-level predictor variables. In addition, as we did not assess all variables at the same time, common method variance is less of a problem because variables measured at different points in time are less likely to suffer from common method bias (Podsakoff *et al.*, 2003).

The use of self-report measures also implies that our study only allows for drawing conclusions about subjective workload, particularly subjective time pressure. Research by Zohar *et al.* (2003) has shown that it is mainly subjective workload, rather than objective workload, that is related to affective responses such as positive affect or fatigue. Therefore, future research should try to disentangle the effects of subjective versus objective workload on vigour, for example by using observational methods for assessing objective workload (Semmer, Grebner, & Elfering, 2004). However, with respect to work hours as predictors of vigour, the subjective measure is less of a problem, as the report of hours worked is assumed to be less biased by the self-report nature of the measure (Frese & Zapf, 1988).

Strictly speaking, we can not infer causality from our study design. However, as we assessed one of our predictor variables (i.e. recovery) before we measured the outcome variable (i.e. vigour), because we used person-mean centred predictor variables (and therefore can rule out stable individual differences as third variables explaining the study findings) and because we did not find any evidence for reverse causation, we minimized alternative interpretations.

In our study, we used paper-and-pencil daily surveys for assessing the day-specific measures. Although we provided our participants with detailed instructions about when

to complete the day-specific items, we cannot be completely sure that all participants complied with the instructions at all times. Thus, one might argue that potentially inaccurate completion times might have influenced our study findings. However, recent research suggests that results from paper-and-pencil diaries do not differ significantly from results from electronic diaries that allow for a detailed tracking of study participants' compliance (Green, Rafaeli, Bolger, Shrout, & Reis, 2006, Study 2). Therefore, we believe that the use of paper-and-pencil daily surveys is not a major threat to the reliability of our study findings.

Practical implications and directions for future research

Assuming that the significant associations between workload and accumulated recovery on the one hand and vigour on the other hand at least partly reflect causality, our study has implications for individuals and management practices in organizations. First, with respect to workload, our results suggest that it is important to keep time pressure and numbers of hours worked within reasonable limits. It is important that managers pay attention to their subordinates' workload and work hours in order to help them sustain vigour throughout the workday. If time pressure and long work hours cannot be avoided, managers and employees themselves may want to take specific measures to prevent low levels of vigour. Whenever possible, in times of high workload, some time should be allocated to work tasks that provide rather than drain energy. For example, tasks that meet individuals' need for autonomy, competence and relatedness (Reis *et al.*, 2000) may be very valuable 'energizers' in time of high workload (cf. Xanthopoulou, Bakker, Demerouti, & Schaufeli, in press). Moreover, particularly in times of high workload, restorative work breaks (Trogakos *et al.*, 2008) should be scheduled and must not be skipped. Spending some time in a natural environment or exercising during the work break might contribute to recovery processes during such breaks (Hansen, Stevens, & Coast, 2001; Hartig, Evans, Jamner, Davis, & Gärling, 2003). Moreover, it seems useful to schedule work in such a way that periods of high workload do not continue for a long time.

Second, it is important that employees spend their leisure time in a way that facilitates optimal recovery. Engaging in sport and other physical activities and psychologically detaching oneself from work during leisure time are two important factors relevant for experiencing recovery (Sonnentag, 2001; Sonnentag & Krueger, 2006). In addition, specific training programs may teach employees how to recover optimally during non-work time (Weh & Sonnentag, 2007). Managers may encourage employees to use their leisure time for recovery by limiting work hours, refraining from calling employees at home, and setting expectations that employees do not need to answer e-mails at home (cf. Eden, 2001). As home workload was negatively related to accumulated recovery (Table 1), reducing workload at home and in the family might help to create better opportunities for recovery. Third, managers may also consider ways to increase employees' general vigour levels, for example by providing appropriate contextual features and resources at the job such as decision-making discretion, a climate of trust and respect, and positive meaning (Spreitzer *et al.*, 2005), by reducing the level of job strain (Lerner *et al.*, 1994), and by building high-quality connections at work (Quinn & Dutton, 2005).

The findings of our study point to interesting questions to be addressed in future research. Future studies might examine the effects of vigour on affect and behaviours off the job. It would be particularly interesting to examine if vigour at the end of the

working day is related to behaviour at home. Without explicitly addressing vigour, between-person research has shown that engagement at work is related to engagement at home, particularly in men (Rothbard, 2001).

It would be an interesting and important goal for future research to identify moderators of the relationship between high daily workload and vigour at the end of the working day. Maybe positive experiences work such a landing a big sale or energizing encounters with customers or co-workers might buffer the negative relationship between workload and vigour.¹ In addition, when examining the consequences of recovery on vigour and other outcomes, greater attention should be paid to the role of sleep. For example, refreshing sleep might compensate for lack of recovery during evening hours.

Future studies may also assess vigour at multiple occasions per day and analyse vigour trajectories throughout the working day. Related to this idea, it would be particularly interesting if future studies paid more attention the processes by which individuals actively regulate their vigour levels throughout the day. For example, it might be that when feeling fully recovered, individuals are more able to engage in work tasks or relationship behaviours that increase their vigour levels, whereas when not fully recovered, individuals remain rather passive and miss the opportunity to increase their degree of vigour. In terms of methodological improvements, future studies might want to extend the period of data collection and include more objective measures of vigour. One option could be to assess objective sleepiness by analysing EEG readings (Lowden *et al.*, 2004).

Conclusion

Taken together, this study adds to the literature on the interface between the work and non-work domain (Edwards & Rothbard, 2000), and contributes empirical evidence to the popular discussion about how individuals can increase and sustain their energy levels (e.g. Loehr & Schwartz, 2003). Specifically, our study suggests that recovery experiences accumulated in the non-work domain are related to vigour - even after work, whereas high levels of day-specific workload drain energy. Therefore, it is particularly important for employees to spend their non-work time in a way that results in true recovery. Moreover, it is crucial to limit daily work hours and to support employees in managing a high level of workload, for example by training time-management skills (Koch & Kleinmann, 2002).

Acknowledgements

This research was supported in part by a grant from the University of Konstanz to the first author (AFF 12/00). This support is gratefully acknowledged. We thank Verena Friedrich, Julia Göbber, Astrid Kassner, and Anne Rohn for their help with data collection and Carmen Binnewies, Adam M. Grant, Jeffrey Greenhaus, and two anonymous reviewers for very helpful and constructive comments on earlier versions of this paper. A preliminary version of this paper has been presented to the Conference on Positive Organizational Scholarship, December 7-9, 2006, Ann Arbor, MI. All the supportive comments of the conference participants on this paper are also highly appreciated.

¹ We are grateful to one anonymous reviewer suggesting this interpretation.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.
- Ashby, F. G., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review*, *106*, 529–550.
- Binnewies, C., Sonnentag, S., & Mojza, E. J. (in press). Daily performance at work: Feeling recovered in the morning as a predictor of day level performance. *Journal of Organizational Behavior*.
- Bolger, N., & Schilling, E. A. (1991). Personality and the problems of everyday life: The role of neuroticism in exposure and reactivity to daily stressors. *Journal of Personality*, *59*, 355–386.
- Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Application and data analysis methods*. Newbury Park, CA: Sage.
- Bullinger, M., Heinisch, M., Ludwig, M., & Geier, S. (1990). Skalen zur Erfassung des Wohlbefindens: Psychometrische Analysen zum 'Profile of Mood States' (POMS) und zum 'Psychological General Wellbeing Index' (PGWI) [Scales for assessing well being: Psychometric analyses of the 'Profile of Mood States' (POMS) and the 'Psychological General Wellbeing Index' (PGWI)]. *Zeitschrift für Differentielle und Diagnostische Psychologie*, *11*, 53–61.
- Butler, A., Grzywacz, J. G., Bass, B. L., & Linney, K. D. (2005). Extending the demands control model: A daily diary study of job characteristics, work family conflict, and work family facilitation. *Journal of Occupational and Organizational Psychology*, *78*, 155–169.
- Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. *Annual Review of Psychology*, *50*, 191–214.
- Craig, A., & Cooper, R. E. (1992). Symptoms of acute and chronic fatigue. In A. P. Smith & D. M. Jones (Eds.), *Handbook of human performance* (Vol. 3, pp. 289–339). London: Academic Press.
- Davis, J. P., Green, P. J., Martin, R., & Suls, J. (1997). Differential roles of neuroticism, extraversion, and event desirability for mood in daily life: An integrative model of top down and bottom up influences. *Journal of Personality and Social Psychology*, *73*, 149–159.
- De Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., & Bongers, P. M. (2003). 'The very best of the millennium': Longitudinal research and the demand control (support) model. *Journal of Occupational Health Psychology*, *8*, 282–305.
- deCroon, E. M., Sluiter, J. K., & Blonk, R. W. B. (2004). Stressful work, psychological job strain, and turnover: A 2 year prospective cohort study of truck drivers. *Journal of Applied Psychology*, *89*, 442–454.
- Demerouti, E., Bakker, A. B., de Jonge, J., Janssen, P. P. M., & Schaufeli, W. B. (2001). Burnout and engagement at work as a function of demands and control. *Scandinavian Journal of Work Environment and Health*, *27*, 279–286.
- Eden, D. (2001). Job stress and respite relief: Overcoming high tech tethers. In P. L. Perrewé & D. C. Ganster (Eds.), *Research in occupational stress and well being: Exploring theoretical mechanisms and perspectives* (pp. 143–194). New York: JAI Press.
- Edwards, J. R., & Rothbard, N. P. (2000). Mechanisms linking work and family: Clarifying the relationship between work and family constructs. *Academy of Management Review*, *25*, 178–199.
- Eid, M., & Diener, E. (1999). Intraindividual variability in affect: Reliability, validity, and personality correlates. *Journal of Personality and Social Psychology*, *76*, 662–676.
- Emmons, R. A., Diener, E., & Larson, R. J. (1986). Choice and avoidance of everyday situations and affect congruence: Two models of reciprocal interactionism. *Journal of Personality and Social Psychology*, *51*, 815–826.
- Fisher, C. D. (2002). Antecedents and consequences of real time affective reactions at work. *Motivation and Emotion*, *26*, 3–30.
- Fisher, C. D., & Noble, C. S. (2004). A within person examination of correlates of performance and emotions while working. *Human Performance*, *17*, 145–168.

- Frese, M., & Fay, D. (2001). Personal initiative: An active performance concept for work in the 21st century. In B. M. Staw & R. L. Sutton (Eds.), *Research in organizational behavior*, (Vol. 23, pp. 133–187) Stamford, CT: JAI Press.
- Frese, M., & Zapf, D. (1988). Methodological issues in the study of work stress: Objective vs. subjective measurement and the question of longitudinal studies. In C. L. Cooper & R. Payne (Eds.), *Causes, coping, and consequences of stress at work* (pp. 375–411). New York: Wiley.
- Frese, M., & Zapf, D. (1994). Action as the core of work psychology: A German approach. In H. C. Triandis, M. D. Dunnette, & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology* (2nd ed., Vol. 4, pp. 271–340). Palo Alto, CA: Consulting Psychologists Press.
- Fritz, C., & Sonnentag, S. (2005). Recovery, health, and job performance: Effects of weekend experiences. *Journal of Occupational Health Psychology, 10*, 187–199.
- Fritz, C., & Sonnentag, S. (2006). Recovery, well being, and performance related outcomes: The role of workload and vacation experiences. *Journal of Applied Psychology, 91*, 936–945.
- Geurts, S. A. E., Kompier, M. A. J., & Roxburgh, S. (2003). Does work-home interference mediate the relationship between workload and well-being? *Journal of Vocational Behavior, 63*, 532–559.
- Geurts, S. A. E., & Sonnentag, S. (2006). Recovery as an explanatory mechanism in the relation between acute stress reactions and chronic health impairment. *Scandinavian Journal of Work, Environment and Health, 32*, 482–492.
- Grant, A. M., & Ashford, S. J. (in press). The dynamics of proactivity at work. *Research in Organizational Behavior*.
- Green, A. S., Rafaeli, E., Bolger, N., ShROUT, P. E., & Reis, H. T. (2006). Paper or plastic? Data equivalence in paper and electronic diaries. *Psychological Methods, 11*, 87–105.
- Greenhaus, J. H., & Beutell, N. J. (1985). Sources of conflict between work and family roles. *Academy of Management Review, 10*, 76–88.
- Greenhaus, J. H., & Powell, G. N. (2006). When work and family are allies: A theory of work-family enrichment. *Academy of Management Journal, 31*, 72–92.
- Gump, B. (1997). Vitality and vigor. *John D. and Catherine T. MacArthur Research Network on Socioeconomic Status and Health*. www.macses.ucsf.edu/Research/Psychosocial/notebook/vitality.html. Retrieved from the Internet 2 November 2007.
- Hansen, C. J., Stevens, L. C., & Coast, J. R. (2001). Exercise duration and mood state: How much is enough to feel better? *Health Psychology, 20*, 267–275.
- Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology, 23*, 109–123.
- Hobfoll, S. E. (1998). *Stress, culture, and community: The psychology and physiology of stress*. New York: Plenum.
- Hockey, G. R. J., & Earle, F. (2006). Control over the scheduling of simulated office work reduces the impact of workload on mental fatigue and task performance. *Journal of Experimental Psychology: Applied, 12*, 50–65.
- Ilies, R., Schwind, K. M., Wagner, D. T., Johnson, M. D., DeRue, D. S., & Ilgen, D. R. (2007). When can employees have a family life? The effects of daily workload and affect on work-family conflict and social behavior at work. *Journal of Applied Psychology, 92*, 1368–1379.
- Ilies, R., Scott, B. A., & Judge, T. A. (2006). The interactive effects of personal traits and experienced states on intraindividual patterns of citizenship behavior. *Academy of Management Journal, 49*, 561–575.
- Jennings, J. R., Kamarck, T., Manuck, S., Eversion, S. A., Kaplan, G., & Solonen, J. T. (1997). Aging or disease? Cardiovascular reactivity in Finnish men over the middle years. *Psychology and Aging, 12*, 225–238.
- Judge, T. A., & Ilies, R. (2004). Affect and job satisfaction: A study of their relationship at work and at home. *Journal of Applied Psychology, 89*, 661–673.
- Kivimäki, M., Leino-Arjas, P., Kaila-Kangas, L., Lukkonen, R., Vahtera, J., Elovainio, M., et al. (2006). Is incomplete recovery from work a risk marker of cardiovascular death? Prospective evidence from industrial employees. *Psychosomatic Medicine, 68*, 402–407.

- Koch, C. J., & Kleinmann, M. (2002). A stitch in time saves nine: Behavioural decision making explanations for time management problems. *European Journal of Work and Organizational Psychology, 11*, 199–217.
- Larsen, R. J., & Ketelaar, T. (1989). Extraversion, neuroticism and susceptibility to positive and negative mood induction procedures. *Personality and Individual Differences, 10*, 1221–1228.
- Larsen, R. J., & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology, 61*, 132–140.
- Lerner, D. J., Malspeis, S., & D'Agostino, R. B. (1994). Job strain and health related quality of life in a national sample. *American Journal of Public Health, 84*, 1580–1585.
- Linden, W., Earle, T. L., Gerin, W., & Christenfeld, N. (1997). Physiological stress reactivity and recovery: Conceptual siblings separated at birth? *Journal of Psychosomatic Research, 42*, 117–135.
- Loehr, J., & Schwartz, T. (2003). *The power of full engagement*. New York: Free Press.
- Lowden, A., Holmbäck, U., Akerstedt, T., Forslund, J., Lennernäs, M., & Forslund, A. (2004). Performance and sleepiness during a 24 h wake in constant conditions are affected by diet. *Biological Psychology, 65*, 251–263.
- Lundberg, U., Mardberg, B., & Frankenhaeuser, M. (1994). The total workload of male and female white collar workers as related to age, occupational level and number of children. *Scandinavian Journal of Psychology, 35*, 315–327.
- Major, V. S., Klein, K. J., & Ehrhart, M. G. (2002). Work time, work interference with family, and psychological distress. *Journal of Applied Psychology, 87*, 427–436.
- Marco, C. A., & Suls, J. (1993). Daily stress and the trajectory of mood: Spillover, response assimilation, contrast and chronic negative affectivity. *Journal of Personality and Social Psychology, 64*, 1053–1063.
- Mardberg, B., Lundberg, U., & Frankenhaeuser, M. (1991). The total workload of parents employed in white collar jobs: Construction of a questionnaire and a scoring system. *Scandinavian Journal of Psychology, 32*, 233–239.
- McNair, D. M., Lorr, M., & Droppelman, L. F. (1971). *Edits manual for the profile of mood states*. San Diego, CA: Educational and Industrial Testing Service.
- Meijman, T. F., & Mulder, G. (1998). Psychological aspects of workload. In P. J. D. Drenth & H. Thierry (Eds.), *Handbook of work and organizational psychology, Vol. 2: Work psychology* (pp. 5–33). Hove, UK: Psychology Press.
- Muraven, M., & Baumeister, R. F. (2000). Self regulation and depletion of limited resources: Does self control resemble a muscle? *Psychological Bulletin, 126*, 247–259.
- Neal, M. B., & Hammer, L. B. (2007). *Working couples caring for children and aging parents: Effects on work and well being*. Mahwah, NJ: Erlbaum.
- Nix, G. A., Ryan, R. M., Manly, J. B., & Deci, E. L. (1999). Revitalization through self regulation: The effects of autonomous and controlled motivation on happiness and vitality. *Journal of Experimental Social Psychology, 35*, 266–284.
- Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues. A handbook and classification*. New York: Oxford University Press.
- Podsakoff, N. P., LePine, J. A., & LePine, M. A. (2007). Differential challenge stressor hindrance stressor relationships with job attitudes, turnover intention, turnover, and withdrawal behavior: A meta analysis. *Journal of Applied Psychology, 92*, 438–454.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879–903.
- Puetz, T. W., O'Connor, P. J., & Dishman, R. K. (2006). Effects of chronic exercise on feelings of energy and fatigue: A quantitative synthesis. *Psychological Bulletin, 132*, 866–876.
- Quinn, R. W., & Dutton, J. E. (2005). Coordination as energy in conversation. *Academy of Management Review, 30*, 36–57.

- Rasbash, J., Browne, W., Goldstein, H., Yang, M., Plewis, I., Healy, M., *et al.* (2000). *A user's guide to MLwiN*. London, UK: Multilevel models project institute of education, University of London.
- Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, J., & Ryan, R. M. (2000). Daily well being: The role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin*, *26*, 419–435.
- Repetti, R. L., & Wood, J. (1997). Effects of daily stress at work on mothers' interactions with preschoolers. *Journal of Family Psychology*, *11*, 90–108.
- Rook, J. W., & Zijlstra, F. R. H. (2006). The contribution of various types of activities to recovery. *European Journal of Work and Organizational Psychology*, *15*, 218–240.
- Rothbard, N. P. (2001). Enriching or depleting? The dynamics of engagement in work and family roles. *Administrative Science Quarterly*, *46*, 655–684.
- Ryan, R. M., & Deci, E. L. (2000). Self determination theory and the facilitation of intrinsic motivation, social development, and well being. *American Psychologist*, *55*, 68–78.
- Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well being. *Journal of Personality*, *65*, 529–565.
- Schaufeli, W. B., Bakker, A. B., & Salanova, M. (2006). The measurement of work engagement with a short questionnaire. A cross national study. *Educational and Psychological Measurement*, *66*, 701–716.
- Scott, B. A., & Judge, T. A. (2006). Insomnia, emotions, and job satisfaction: A multilevel study. *Journal of Management*, *32*, 622–645.
- Semmer, N. (1984). *Stressbezogene Tätigkeitsanalyse [Stress oriented task analysis]*. Weinheim: Beltz.
- Semmer, N. (2003). Job stress interventions and organization of work. In J. C. Quick & L. E. Tetrick (Eds.), *Handbook of occupational health psychology* (pp. 325–353). Washington, DC: American Psychological Association.
- Semmer, N. K., Grebner, S., & Elfering, A. (2004). Beyond self report: Using observational, physiological, and situation based measures in research on occupational stress. In P. L. Perrewé & D. C. Ganster (Eds.), *Research in occupational stress and well being: Emotional and physiological processes and positive intervention strategies* (Vol. 3, pp. 205–263). Amsterdam, NL: Elsevier.
- Sheldon, K. M., Ryan, R., & Reis, H. T. (1996). What makes for a good day? Competence and autonomy in the day and in the person. *Personality and Social Psychology Bulletin*, *22*, 1270–1279.
- Shirom, A. (2004). Feeling vigorous at work? The construct of vigor and the study of positive affect in organizations. In D. Ganster & P. L. Perrewé (Eds.), *Research in organizational stress and well being* (pp. 135–165). Greenwich, CN: JAI Press.
- Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis. An introduction to basic and advanced multilevel modelling*. London: Sage.
- Sonnentag, S. (2001). Work, recovery activities, and individual well being: A diary study. *Journal of Occupational Health Psychology*, *6*, 196–210.
- Sonnentag, S. (2003). Recovery, work engagement, and proactive behavior: A new look at the interface between non work and work. *Journal of Applied Psychology*, *88*, 518–528.
- Sonnentag, S., & Krueger, U. (2006). Psychological detachment from work during off job time: The role of job stressors, job involvement, and recovery related self efficacy. *European Journal of Work and Organizational Psychology*, *15*, 197–217.
- Sonnentag, S., & Natter, E. (2004). Flight attendants' daily recovery from work: Is there no place like home? *International Journal of Stress Management*, *11*, 366–391.
- Spector, P. E., & Jex, S. M. (1998). Development of four self report measures of job stressors and strain: Interpersonal conflict at work scale, organizational constraints scale, quantitative workload inventory, and physical symptoms inventory. *Journal of Occupational Health Psychology*, *3*, 356–367.
- Spreitzer, G., Sutcliffe, K., Dutton, J., Sonenshein, S., & Grant, A. M. (2005). A socially embedded model of thriving at work. *Organization Science*, *16*, 537–549.

- Teuchmann, K., Totterdell, P., & Parker, S. K. (1999). Rushed, unhappy, and drained: An experience sampling study of relations between time pressure, perceived control, mood, and emotional exhaustion in a group of accountants. *Journal of Occupational Health Psychology, 4*, 37-54.
- Thayer, R. E. (1987). Energy, tiredness, and tension effects of a sugar snack versus moderate exercise. *Journal of Personality and Social Psychology, 52*, 119-125.
- Thayer, R. E. (2001). *Calm energy: How people regulate mood with food and exercise*. New York: Oxford University Press.
- Totterdell, P., Spelten, E., Smith, L., Barton, J., & Folkard, S. (1995). Recovery from work shifts: How long does it take? *Journal of Applied Psychology, 80*, 43-57.
- Totterdell, P., Wood, S., & Wall, T. (2006). An intra-individual test of the demands-control model: A weekly diary study of psychological strain in portfolio workers. *Journal of Occupational and Organizational Psychology, 79*, 63-84.
- Trougakos, J. P., Beal, D. J., Green, S. G., & Weiss, H. M. (2008). Making the break count: An episodic examination of recovery activities, emotional experiences, and affective delivery. *Academy of Management Journal, 51*, 131-146.
- Uchino, B. N., Berg, C. A., Smith, T. W., Pearce, G., & Skinner, M. (2006). Age-related differences in ambulatory blood pressure with daily stress: Evidence for greater blood pressure reactivity with age. *Psychology and Aging, 21*, 231-239.
- van Steenbergen, E. F., Ellemers, N., & Mooijart, A. (2007). How work and family can facilitate each other: Distinct types of work-family facilitation and outcomes for women and men. *Journal of Occupational Health Psychology, 12*, 279-300.
- Watson, D., & Clark, L. A. (1994). *The PANAS-X. Manual for the positive and negative affect schedule*. Iowa: University of Iowa.
- Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*, 820-838.
- Weh, S.-M., & Sonnentag, S. (2007). Positive experiences off the job: Results from an intervention study on changes in psychological well-being. *Paper presented at the Annual Meeting of the Academy of Management, Philadelphia, PA (August 2007)*.
- Westman, M., & Eden, D. (1997). Effects of a respite from work on burnout: Vacation relief and fade-out. *Journal of Applied Psychology, 82*, 516-527.
- Xanthopoulou, D., Bakker, A. B., Demerouti, E., & Schaufeli, W. B. (in press). Work engagement and financial returns: A diary study on the role of job and personal resources. *Journal of Occupational and Organizational Psychology*.
- Zapf, D. (1993). Stress-oriented analysis of computerized office work. *European Work and Organizational Psychologist, 3*, 85-100.
- Zautra, A. J., Affleck, G. G., Tennen, H., Reich, J. W., & Davis, M. C. (2005). Dynamic approaches to emotions and stress in everyday life: Bolger and Zuckerman reloaded with positive as well as negative affects. *Journal of Personality, 73*, 1511-1538.
- Zohar, D., Tzischinski, O., & Epstein, R. (2003). Effects of energy availability on immediate and delayed emotional reactions to work events. *Journal of Applied Psychology, 88*, 1082-1093.